

Bone. Fig. 29, *P. antillarum* Recluz; photo by Bone. Fig. 30, *Pecten kallinubilosus*, sp. nov., type, upper valve; alt. 36, lat. 38.5 mm.; photo by Rogers. Fig. 31, same, lower valve. Fig. 32, same, interior of upper valve.

Plate 15. Fig. 33, *Pseudochama inezae*, n. sp., Type; diam. maj. 42, min. 38 mm.; all figs. by Mr. Charles C. Sherley. a, Exterior of right valve. b, Exterior of left valve. c, Interior of left valve. d, Interior of right valve. The fine shagreen surface, or granulation, is easily seen at margins of shell in fig. d; present but not noticeable in c.

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## A PRELIMINARY REVISION OF THE RECENT SPECIES OF CHINESE VIVIPARIDAE<sup>1</sup>

BY TENG-CHIEN YEN

One of the most comprehensive monographs of Viviparidae is Kobelt's work, in continuation of Kuester's, on "*Paludina* Lam.—*Vivipara* Montf.," which was issued at different intervals during 1906–1909 in the new edition of *Conchylien-Cabinet* by Martini and Chemnitz. This work has practically included all the forms of the family known to the author at that time. Since then, this group of freshwater mollusks was subsequently studied by a number of authors, notably Annandale (1920, 1921, 1924) and Rao (1925, 1928), whose attention was particularly directed to the Asiatic forms; Prashad (1928) presenting a synthetic study in distribution and evolution of both recent and fossil Viviparidae; and Kuroda (1929) on the classification of the Japanese forms.

But, nevertheless, a revised synopsis of the family in generic and minor divisions was not available till the publication of the first part of Thiele's "Handbuch" in 1929. Later on in 1936, Taki also attempted to present a "Revision of System of Viviparidae," but his "revision" does not seem to make any important change other than reducing a few of Thiele's subgenera to sections (*Bellamyia* Jousseaume, *Dactylochlamys* Rao = *Angulyagra* Rao, *Heterogen* Annandale, etc.) and his genera into subgenera (*Rivularia* Heude, *Margarya* Nevill, *Neothauma* Smith and *Tulotoma* Haldeman). Such changes do not seem to offer a better background for further study of the family and sometimes may cause confusion.

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However, an important contribution by Rohrbach, which casts new light on the revision of Viviparidae, came to our attention in 1937. On the basis of a comparative study of *Bellamya unicolor* and its allied forms, the author was led to the conclusion that these African forms should be separated from the typical *Viviparus*, and they show close relationship to the species of *Cipangopaludina*.

In the following pages I attempt to arrange the species of Viviparidae so far known from China into their proper genera. Most of these species has been hitherto assigned to *Viviparus* (s. l.), although the attention has been called previously, for a few of these forms, by Annandale, Rao, Prashad and others, that they should be separated from the typical *Viviparus*. Moreover, all the genera comprised in the present work have been generally accepted by recent authors, and their generic ranks seem to be well established.

In addition to the 68 species and subspecies treated in this work, there are two more forms which can only be considered as doubtful in generic position. One is *Paludina deformis* Heude 1890 (Mem., p. 130, pl. 25, fig. 8-9), another is *Paludina heudei* Ping 1938 (Bull. Mus. Heude, Malac., I (5), p. 2, pl. 1, fig. 1-2, non Dautzenberg et Fischer 1905).

Genus VIVIPARUS Montfort, 1810, Conch. Syst., II, p. 247.

Genotype: *Helix vivipara* Linné.

The genus is used here in *sensu stricto* which has been hitherto used in *sensu lato* for many of the Chinese species. More closely related species of this kind may be represented by a few comparatively small-shelled and banded forms found in the northeastern provinces of China. These forms were formerly supposed by authors to be more closely related to *Cipangopaludina chinensis* (Gray) or *Bellamya quadrata* (Benson), but they are different from the former by the smaller size and thicker shell substance, and from the latter by the more roundly convex whorls, destitute of spiral sculpture and peripheral keel. These forms seem to resemble closely such species as *V. viviparus* and *V. contectus* which exist so commonly in Europe as far as to western Siberia. These forms are often banded but the color bands are sometimes absent or only faintly traceable inside of the aperture. The apical whorls, as often well preserved in the young but decollated

in the adult, are rather depressed or nearly flattened, never being mucronate as that of the species of *Cipangopaludina*. Two species are at present known and their geographic range does not seem to extend further south than Kirin province.

*Viviparus praerosus* (Gerstfeldt 1859)—Amur region  
*V. chui* Yen 1937—Kirin, Kirin province

Genus BELLAMYA Jousseume, 1886, Bull. Soc. Zool. France, XI, p. 478. Genotype: *Paludina bellamya* Jousseume.

A number of Chinese species which has hitherto assigned into *Viviparus* (s. l.) or a group called "*Vivipari Dissimiles*," seems to be well included into *Bellamya*. As already pointed out by Rohrbach in 1937, this group is different from the typical species of *Viviparus*, and the relationship among *B. unicolor*, *dissimilis* and *quadrata* was well discussed by Prashad in 1928 (p. 180).

Moreover, it differs from other genera such as *Cipangopaludina* and *Angulyagra* by its more or less oblong outline of shells, smaller size, obtusely or strongly keeled at the periphery, thinner columellar margin and having scarcely convex or rather flattened whorls.

*Bellamya quadrata* (Benson 1842)—Chow-shan Island, Chekiang

Syn. *purificata* Heude 1890—Siang river, Hunan

*chengtehensis* Taki 1936—Chengteh, Jehol

*B. quadrata minor* (Nevill 1885)—Kulangsu, Amoy, Fukien

*B. q. reevei* (Dautzenberg et Fischer 1905)

Syn. *quadrata* Reeve, non Benson,—Shanghai, Kiangsu

*B. q. boettgeri* (Heude 1890)—Hainan Island, Kwangtung

*B. q. orientalis* (Lea 1860)—China

Syn. *aeruginosa* Reeve 1863—Canton, Kwangtung

*B. q. turrita* (Yen 1939)—Canton, Kwangtung

*B. q. ecarinata* (Kobelt 1906)—north river, Canton, Kwangtung

*B. q. aculecarinata* (Kobelt 1906)—Canton, Kwangtung

*B. q. dispiralis* (Heude 1890)—Yunnan

*B. q. fantozatiana* (Heude 1890)—upper Han river, Hupei

*B. q. lapillorum* (Heude 1890)—Ningkuo-hsien, Anhwei

*B. q. heudei* (Dautzenberg et Fischer 1905)

Syn. *aeruginosa* Heude, non Reeve,—Yangtze valley

*Bellamya lithophaga* (Heude 1889)—Ningkuo-hsien, Anhwei

*B. demolita* (Heude 1890)—Kwangtuh, Anhwei

*B. smithi* (Yen 1942)—Hunan

*B. limnophila* (Mabille 1886)—Ta-li-fu, Yunnan

*B. secernenda* (Mabille 1886)—Ta-li-fu, Yunnan

*B. margaryoides* (Annandale 1924)—Ta-li-fu, Yunnan

Genus CIPANGOPALUDINA Hannibal, 1912, Proc. Malac. Soc. Lond., X, p. 194. Genotype: *Paludina malleata* Reeve.

The name was proposed by the author as a subgenus of *Idiopoma*, and its description was based on several lots of "introduced" specimens collected in California which were identified as *P. malleata* Reeve. In 1920 Annandale proposed *Lecythoconcha* as a distinct genus for *Paludina lecythis* Benson and its allied forms, which, as pointed out by Prashad 1928, fall into the same group of species for which *Cipangopaludina* was described. The former has thus invalidated the latter. It was treated as a section of *Viviparus* by Thiele.

The generic characters were well described by Annandale 1920 for *Lecythoconcha* (Rec. Ind. Mus., p. 114) and subsequently by Rao in 1925 (Rec. Ind. Mus., p. 133) and in 1928 (ibidem, p. 421). It has a wide distribution in Eastern Asia as far west as Burma and Northern India and it was introduced into North America. The following forms have been described from China:

*Cipangopaludina chinensis* (Gray 1834)—China

Syn. *leucostoma* Heude 1890—Peihai, Kwangtung

*diminuta* Heude 1890—Kwangteh, Anhwei

*C. chinensis hainanensis* (Kobelt 1906)—Hainan Island, Kwangtung

*C. c. stelmaphora* Bourguignat 1862—Peking, Hopei

*C. lecythis* (Benson 1836)—Yunnan

*C. lecythoides* (Benson 1842)—Chow-shan Island, Chekiang

*C. l. fluminalis* (Heude 1890)—Yangtze valley

*C. l. aubryana* (Heude 1890)—Kwei-chow

*C. l. occidentalis* (Annandale 1924)—Yunnan

*C. ventricosa* (Heude 1890)—Kwei-chow and Yunnan provinces

*C. v. cathayensis* (Heude 1890)—Yangtze valley

*C. v. wingatei* (Smith 1900)—Hunan

*C. v. patris* (Kobelt 1906)

Syn. *lecythoides* Heude, non Benson, Chow-shan Island, Chekiang

*compacta* Kobelt, non Nevill, Hainan Island, Kwangtung

*lecythis crassior* Annandale 1924—Western Yunnan

*C. haasi* (Prashad 1928)

Syn. *longispira* Heude, non Smith, Chen-tuh, Szechwan

*C. ussuriensis* (Gerstfeldt 1859)—Lower Amur river

*C. lapidea* (Heude 1890)—Chien-tuh, Anhwei

*C. delavayana* (Heude 1889)—Ta-li-fu, Yunnan

*C. latissima* (Dautzenberg et Fischer 1905)—Mongtze, Yunnan

Genus *ANGULYAGRA* Rao, 1931, Rec. Ind. Mus., 33, p. 301.

Genotype: *Paludina oxytropis* Benson.

This genus was proposed by Rao in 1925 as *Dactylochlamys* (non Lauterborn 1901) and renamed by him in 1931 as above. The shell is of moderate size, conical, thin, and bearing spiral ridges. The generic characters were well noted by Rao (Rec. Ind. Mus., 27, p. 132). The species found in China are as follows:

*Angulyagra costata* (Quoy et Gaimard 1832)—Canton, Kwangtung

*A. thersites* (Reeve 1863)—Canton, Kwangtung

*A. oxytropoides* (Heude 1889)—Chao-tung Lake, Yunnan

*A. polyzonata* (Frauenfeld 1862)—(Canton), China

*A. quangdungensis* (Kobelt 1907) Kwangtung

*A. annulata* (Yen 1939)—Hunan

Genus *MARGARYA* Nevill, 1877, Jour. Asiat. Soc. Bengal,

46 (2), p. 30. Genotype: *Margarya melanooides* Nevill.

This genus is so far only known from western part of Yunnan province, a few subspecies or varieties, differentiated by the sculpture, have been recognized by the authors being as follows:

*Margarya melanooides* Nevill 1877—Ta-li Lake, Yunnan

Syn. *tuberculata* Neumayr 1887—Ta-li-lake, Yunnan

*delavayi* Mabille 1886—Ta-li Lake, Yunnan

*M. m. carinata* (Neumayr 1883)—Ta-li Lake, Yunnan

*M. m. francheti* (Mabille 1886)—Ta-li Lake, Yunnan

Syn. *rotundata* Neumayr 1887—Ta-li Lake, Yunnan

*M. m. tropidophora* (Mabille 1886)—Ta-li Lake, Yunnan

*M. m. mansuyi* Dautzenberg et Fischer 1905—Mongtze, Yunnan

*M. m. monodi* Dautzenberg et Fischer 1905—Koui-an, Yunnan

*M. m. obsoleta* Dautzenberg et Fischer 1905—Mongtze, Yunnan

Genus *MEKONGIA* Crosse et Fischer, 1876, Jour. de Conchy.,

24, p. 316. Genotype: *Paludina jullieni* Deshayes.

*Mekongia* was proposed as a subgenus of *Paludina* based on the species *P. jullieni* Deshayes from Ca-Lgniou. It is characterized by its thick shell substance and heavy callus of columellar margin; the outer lip, however thick, seems to be somewhat retreating and aperture more or less contracted. On account of the thick callous margin of columella, I include herewith two species which bear spiral ridges. By examining the species available, I consider the genus as related to the Indian *Taia* on one hand and the Chinese *Rivularia* on the other.

- Mekongia magnaciana* (Heude 1889)—Chungking, Szechwan.  
*M. rusiostoma* (Gredler 1885)—Chin-chi, Kwei-chow  
*M. liuiana* (Yen 1937)—Anhwa, Hunan  
*M. hunanensis* Yen 1942—Hunan  
*M. boettgeri* (Kobelt 1907)—non Heude 1890—Hainan Island, Kwangtung  
*M. wilhelmi* (Yen 1939)—Canton, Kwangtung  
*M. subcostata* (Gray 1834)—China  
*M. rivularis* (Kobelt 1907)—Hunan

Genus RIVULARIA Heude, 1890, Mémoires, p. 179. Genotype: *Paludina auriculata* Martens.

This genus has been so far known from Siang river of Hunan and its neighbouring provinces Kweichow, Kiangse, Hupei and Anhwei.

- Rivularia auriculata* (Martens 1875)—Siang river, Hunan  
*R. elongata* Heude 1890—Tsi-yang river, Hunan  
*R. calcarata* Kobelt 1907—Pao-ching, Hunan  
*R. bicarinata* Kobelt 1907—Hunan  
*R. ibex* Gredler 1894—Hunan  
*R. ovum* Heude 1890—Hunan and Kweichow provinces  
*R. globosa* Heude 1890—Hung river, Hunan  
*R. porcellanea* Kobelt 1907—Ichang, Hupei  
*R. glandina* Heude 1890—Pao-yang Lake, Kiangse  
*R. subelliptica* Heude 1890—Ningkuo-hsien, Anhwei

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## DISTRIBUTION OF FRESH-WATER GASTROPODS IN RELATION TO TOTAL ALKALINITY OF STREAMS

By C. S. SHOUP<sup>1</sup>

During four summers (1938-1941) the biological survey parties of the Tennessee Division of Game and Fish have collected specimens of aquatic mollusks as a part of the fisheries survey work. Lists of some of the species taken have already been published, (Shoup and Peyton, 1940; Shoup, Peyton and Gentry, 1941) and Mr. Calvin Goodrich, who kindly identified the specimens, has already reported (1940) on the sequence of distribution of our species from the Obey River drainage of Tennessee.

At the present time 47 of the most abundant species of gastropods have been obtained from 156 localities out of a total of 420 different collecting stations in the minor watersheds of the principal drainages of the state. Most tributaries from which collections have been taken, particularly in the basin of the Big South Fork of the Cumberland, the Obey River, and nearly the whole of the Tennessee drainage in East Tennessee, flow over bedrock characteristic of a particular geological formation, and in many instances discernible differences in total alkalinity, usually as bicarbonate (acid carbonate) alkalinity, can be definitely assigned to the presence of a particular bedrock stratum characteristic of the individual stream. We have been interested in this geochemistry of the natural waters, and I have attempted to

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